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CLIMATE, SOILS AND VEGETATION OF THE RAMPART RANGE, COLORADO.(U)

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CLIMATE, SOILS AND VEGETATION OF THE RAMPART RANGE, COLORADO

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FINAL REPORT

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UNITED STATES AIR FORCE ACADEMY

COLORADO 80840

Editorial Review by Captain Myers
Department of English
USAF Academy, Colorado 80840

This research report is presented as a competent treatment of the subject, worthy of publication. The United States Air Force Academy vouches for the quality of the research, without necessarily endorsing the opinions and conclusions of the author.

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This report reviews the climate, soils and vegetation of a segment of the Colorado Front Range and adjacent Colorado Piedmont. Variations in temperatures, precipitation, evaporation, and wind are analyzed as are the soil associations. The grassland biome, scrub biome, and coniferous forest biome and their distribution are also described.

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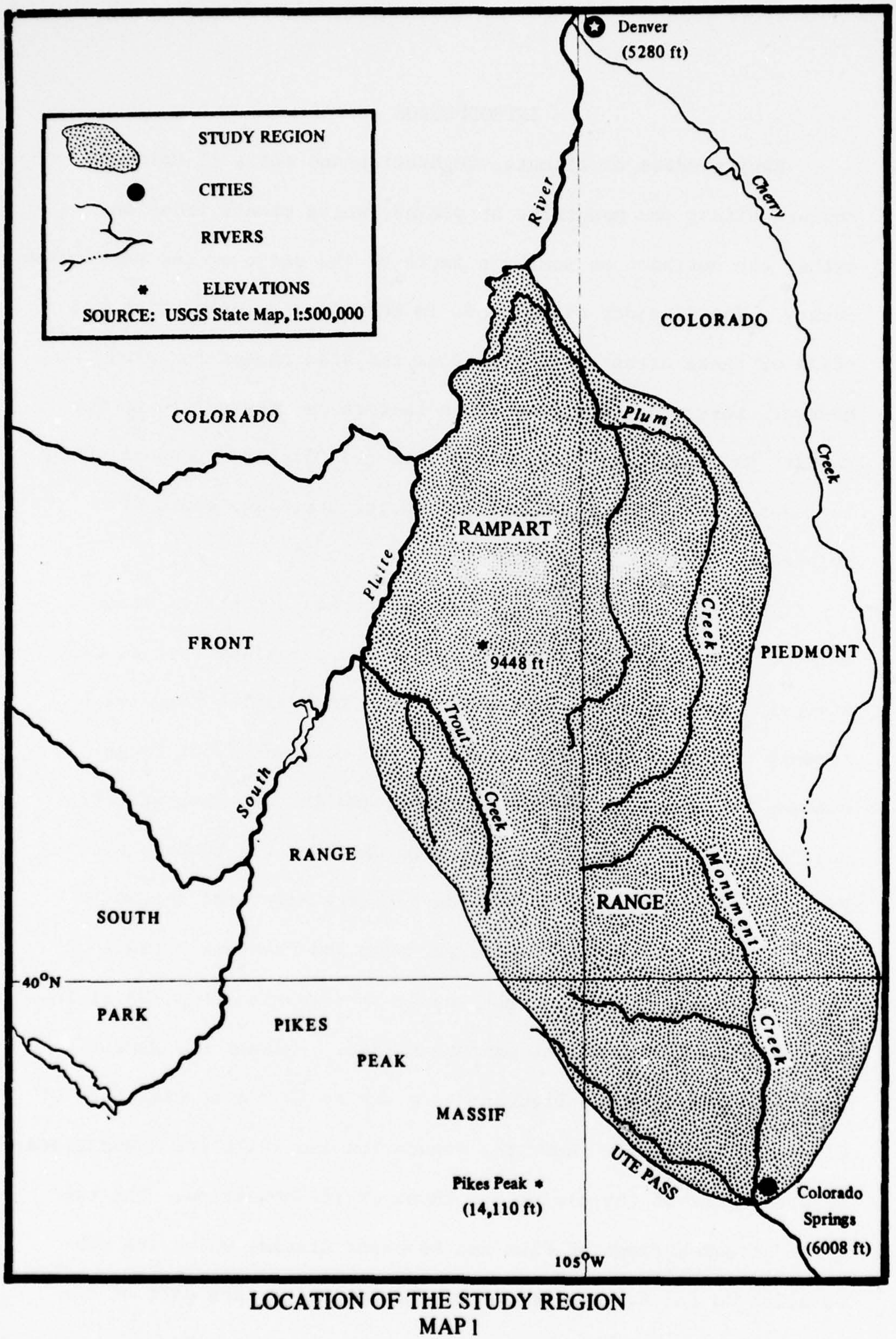
INTRODUCTION

Many studies of climate, vegetation and soils of Colorado concern either the mountains or plains, while others focus on either the northern or southern parts of the state or one particular county. The distinct differences in the climate, vegetation and soils of these areas often determine the area chosen for study. However, this study analyzes these factors as they relate to the Rampart Range and adjacent portions of the Colorado Piedmont which includes both mountains and plains in the north and south of Colorado.

The trapizoidal shaped study region has a north to south axis of approximately fifty-five miles and a maximum east to west dimension of twenty-five miles (Map 1). The Rampart Range is a roughly triangular shaped segment of the Colorado Front Range between the mouth of the Platte Canyon and the Ute Pass west of Colorado Springs. A series of faults which extend through Ute Pass then northwestward to the South Platte River and the South Platte River itself form the south, west and northern borders of the Rampart Range. The abrupt change in elevation from the plains to the mountains forms the eastern border. Between the Rampart Range and the Colorado Piedmont is a two to four mile wide belt of dissected foothills. Here the vegetation and soils are transitional between those of the plains and those of the mountains. The two large stream valleys of Plum and Monument Creeks, which are sub-parallel to the eastern border of the mountains, are part of the



LOCATION OF THE STUDY REGION
MAP 1

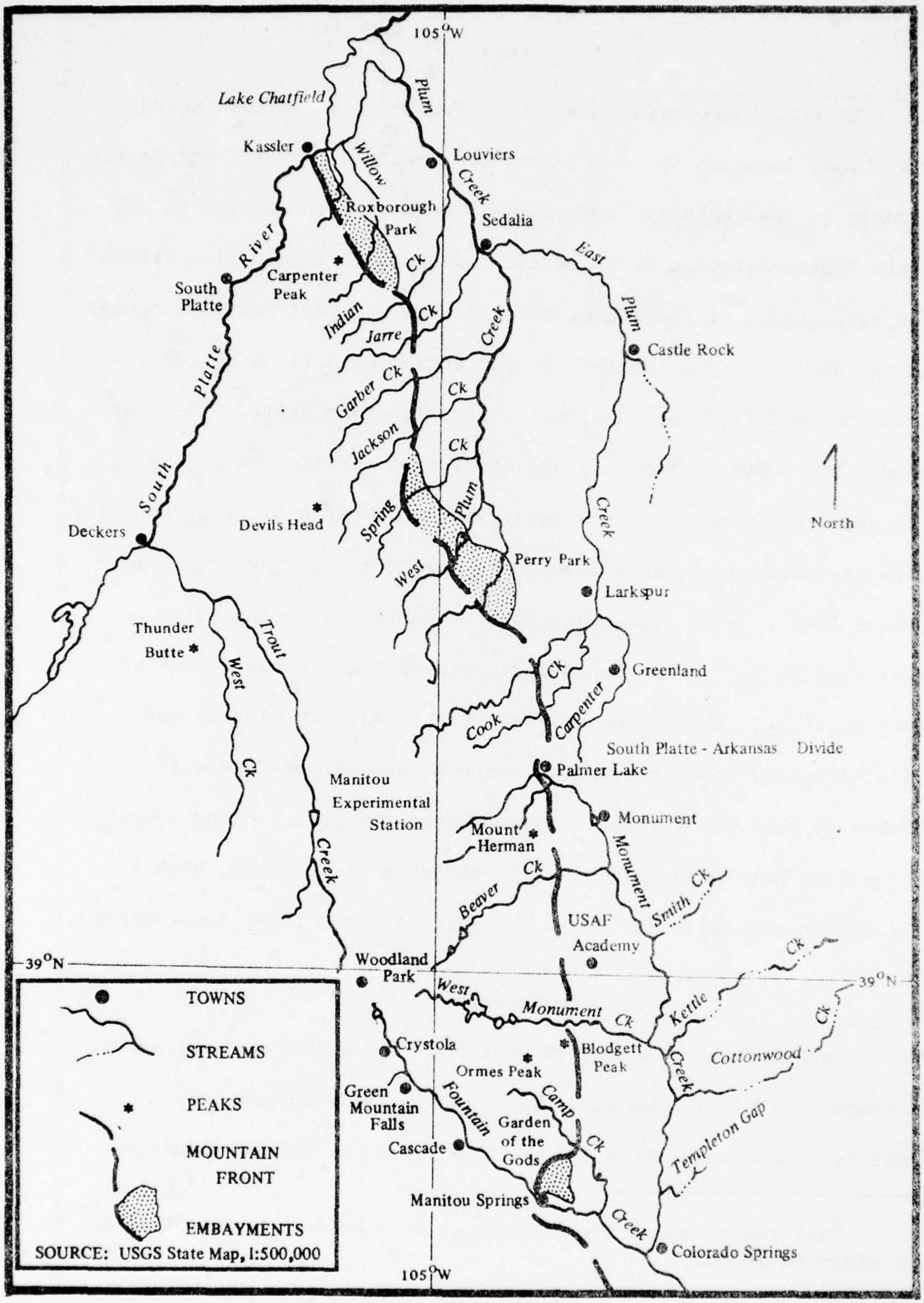
Colorado Piedmont and have been included in the region covered by this report. The valley of Plum Creek contains numerous mesas and buttes which rise several hundred feet above the adjacent streams, while the valley of Monument Creek contains few such features (Photograph 1).

Separating two streams is a broad upland which extends eastward from the base of the Rampart Range. Known as the South Platte-Arkansas Divide, or more simply the divide, this upland is almost 1,500 feet higher than the lowest parts of the region and is cooler and moister than areas to the north and south (Map 2). A one-half mile wide, 200-foot deep, gap breaks the divide adjacent to the mountains near the town of Palmer Lake. The divide also tends to divert isotherms and isohyets eastward.

The initial section of this study focuses upon the climate of the Rampart Range and Colorado Piedmont including temperature, precipitation, and wind. The second section discusses the soil associations of the region. The final section deals with the distribution of the grassland biome, scrub biome, and coniferous forest biome in the area. The conclusion includes a discussion of the relationship between these patterns.

Photograph 1

Butte in Plum Creek Basin



RAMPART RANGE STUDY REGION
MAP 2

CLIMATE[1]

Several factors influence the climate of the study region: elevation, location in relation to the mountains, slope, and particularly in the foothills and plains, location with respect to the South Platte-Arkansas River divide. The entire region lies within the rain shadow of the higher mountains to the west and is included in the BSK or Middle Latitude Steppe region as defined by the Trewartha modified Koppen climate classification system. Semi-arid conditions prevail with only one station of the eight stations in the area receiving more than twenty inches of precipitation annually. Warm days and cool nights tend to be common due to the thin atmospheric layer. This allows a greater amount of incoming solar radiation to reach the ground during the day and a rapid loss of heat at night. The region typically has cool, dry winters and mild, slightly moister summers; however, the winters are often broken by periods of relatively warm temperatures, and the summers frequently have cold spells. Like the rest of Colorado, higher elevations generally have more precipitation and lower temperatures.

Temperature

Seasonal and diurnal temperatures vary greatly. Mean annual temperatures within the study region range from 45° to 52°, January temperatures from 27° to 32.6°, and the July temperatures

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[1] All temperatures are in degrees farenheit and precipitation is given in inches.

range from 60° to 74.4° (Table 1). These temperatures can easily be compared with other parts of the United States. For example, Saint Louis, Missouri, at 38°41'N is about the same latitude as Colorado Springs but has a higher mean annual temperature of 57.5° with a 32° mean in January and 79.5° in July.[2] Thus, the study region is significantly cooler than Saint Louis. Elevation above sea level is one primary reason for this difference. Saint Louis lies at 568 feet, while Colorado Springs is over 6,000 feet. As pointed out in many geography texts, increased elevation results in cooler temperatures.[3]

Elevation

The variation in temperature between Las Animas in the Arkansas Valley and Pikes Peak, only ninety miles away but 6,400 feet higher, demonstrate the effect of elevation upon temperature; the mean annual temperatures differ by 35°--the same difference in temperature as that between southern Florida and Iceland.[4]

Increased elevation in the region usually results in lower temperatures. The locations listed in Table 1 show this inversely

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[2]Frederick L. Wernstedt, World Climate Data (Lemont, Pa.: Climatic Data Press, 1972), p. 69.

[3]Arthur N. Strahler, Physical Geography, 2nd ed. (New York: John Wiley and Sons, Inc., 1960), p. 228.

[4]Joseph W. Berry, Climate of the States-Colorado (Washington, D.C.: Government Printing Office, 1968), p. 2.

TABLE 1

TEMPERATURE DATA FOR SELECTED LOCATIONS*
(degrees fahrenheit)

LOCATION**	MEAN ANNUAL	MEAN JANUARY	MEAN JULY	MAXIMUM	MINIMUM
Denver (5280 Feet)	52.0	32.6	74.4	105	-29
Kassler (5490 Feet)	52.4	32.7	74.0	103	-32
Colorado Springs (6173 Feet)	48.5	28.6	70.5	100	-27
Castle Rock (6205 Feet)	46.4	28.8	67.0	99	-37
Monument (7400 Feet)	46.6	28.4	67.8	100	-40
Manitou Experiment Station (7800 Feet)	45.00	27	60.0	na***	na

* Compiled from various sources
** See Map 2
*** data not available

proportional relationship between altitude and temperature, in mean January and July temperatures as well as mean annual temperatures. However, elevation is not the only factor which affects temperatures. Otherwise, Monument, nearly 1,200 feet higher than Castle Rock, would be colder than Castle Rock. Furthermore, the same anomaly occurs between Kassler and Denver.

Shade

Another relationship exists between temperature and shade. Temperatures taken in the direct sunshine are much higher than those taken in the shade. Because most meteorological data is obtained in the shade, figures used most commonly reflect only a portion of the climate. As elevation increases the difference in temperature between direct sunlight and shade also increases. For example, an elevation of 5,905 feet, 80° in the shade will often be accompanied by a direct sunlight temperature of 111°--a difference of 31°. At 7,644 feet, slightly above the altitude of the Air Force Academy and Monument, 66° in the shade relates to 116° in the sunlight. While on the tops of the Monadonocks or isolated mountain peaks, such as Devil Head and Thunder Butte (Map 2), a difference of 128° between sun and shade temperatures may occur.[5] Thus, the amount of shade has great significance in any analysis

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[5] Julius Hann, Handbook of Climatology. Translated by Robert de Courcy Ward. (New York: The MacMillan Company, 1903), p. 232.

of temperatures. As a result of this information, the mean annual temperatures within the study region may be misleading.

Slope

Amount and direction of slope significantly affect the amount of insolation received by the ground. Obviously a south facing slope will receive more insolation than a north facing slope. This is due to the change in the angle of the sun's rays. In mid-summer, the south facing slopes may be 20° to 25° warmer than flat surfaces. Temperatures of 140° have been recorded on such slopes in the study region.[6] Frank and Lee have compiled tables converting different slope angles and directions to equivalent horizontal surfaces at various latitudes (Tables 2 and 3). For example, in the northern hemisphere, a north facing 10 percent slope at 38° latitude receives the same amount of insolation as a flat surface at 43.7° north. The reverse is also true with respect to south facing slopes. A south facing slope of 10 percent at 38° north receives the same insolation as a horizontal surface at 32.3° north. A slope of 70 percent to the south at 38° is equivalent to a horizontal surface only three degrees from the equator. Not surprisingly, insolation actually decreases for south facing slopes with aspects greater than 70°.[7]

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[6] Carols G. Bates, "Forest Succession in the Central Rocky Mountains, Journal of Forestry, XV (1917), 587-592.

[7] Ernest C. Frank and Richard Lee, Potential Solar Beam Irradiation on Slopes. U.S. Department of Agriculture, Forest Service Research Paper RM-18. (Fort Collins, Colorado: Rocky Mountain Forest and Range Experiment Station, 1966), pp. 48-58.

TABLE 2

SLOPE AND EQUIVALENT LATITUDE
(Northern Hemisphere)

NORTH FACING SLOPES			SOUTH FACING SLOPES		
Latitude (degrees)	Slope (percent)	Equivalent Latitude (degrees)	Latitude (degrees)	Slope (percent)	Equivalent Latitude (degrees)
38	10	43.7	38	10	32.3
38	50	64.4	38	50	11.4
38	100	83.0	38	100	3.0
40	10	45.7	40	10	34.3
40	50	66.6	40	50	13.4
40	100	85.0	40	100	5.0

Source: Frank and Lee, 1966, pp. 48-58.

TABLE 3

PERCENT OF INSOLATION
(Northern Hemisphere)

North Facing Slopes				South Facing Slopes			
Latitude (degree)	Slope (percent)	Potential Insolation	Per Cent of Base	Latitude (degree)	Slope (percent)	Potential Insolation	Per Cent of Base
38	10	241.375	BASE	38	10	276.068	BASE
38	30	200.586	83.10	38	30	300.026	108.67
38	50	160.609	66.53	38	50	312.761	113.29
38	70	129.825	53.78	38	70	316.679	113.71
38	100	98.011	40.06	38	100	312.855	113.32
40	10	234.548	BASE	40	10	270.580	BASE
40	30	192.933	82.25	40	30	296.107	109.43
40	50	153.243	62.92	40	50	310.403	114.71
40	70	123.821	52.79	40	70	315.722	116.68
40	100	92.944	39.62	40	100	313.586	115.89

Source: Frank and Lee, 1966, pp. 48-58.

Location

According to the previous discussion, a south facing slope of 70 percent should receive more insolation than a horizontal surface at the same latitude. Another significant factor, and one which was previously mentioned but is often overlooked in analyzing climatic conditions, is the relative location of the surface with respect to its surroundings. If a 70 percent south facing slope is frequently in the shadow of a high feature, such as a mountain, the amount of insolation received will be smaller than a flat surface which is not in the shadow. Obviously, in such a rugged area as the Rampart Range and the foothills, there are slopes, south facing and north facing, which are in shadow for much of the day. In the deeper parts of Ute Pass near Cascade, the sun may set at 3 p.m. during the summer. When this happens, temperatures in the valley begin to drop quite rapidly.

The combined effect of elevation, shade, slope, and location can cause the temperature regimes of two adjacent valleys to differ by 10 or 15 degrees.

Precipitation

As mentioned, the study region is semi-arid and precipitation is sparse, with the mean annual totals ranging from 12.24 to 23.32 inches per year (Table 4). These low totals are partly due to the long distances from sources of moisture. Air masses entering the region from the west have usually lost most of their moisture in

TABLE 4

PRECIPITATION DATA FOR SELECTED LOCATIONS*
(in inches)

LOCATION**	MEAN ANNUAL TOTAL	MAXIMUM	MINIMUM	SNOW	PERCENT APR-SEPT
Kassler (5490 Feet)	17.41	25.95	11.58	64.1	64.79
Sedalia (6167 Feet)	23.32	25.84	14.24	na***	71.00
Colorado Springs (6173 Feet)	13.19	25.07	10.16	37.9	71.29
Castle Rock (6205 Feet)	13.43	19.09	10.00	60.8	71.81
Manitou Springs (6606 Feet)	16.31	25.63	10.68	na	79.03
Monument (7400 Feet)	18.53	29.93	9.67	85.9	72.18
Manitou Experiment Station (7760 Feet)	12.24	18.49	8.12	na	77.61
Devils Head Ranger Station (9748 Feet)	15.00	na	na	na	na

* Compiled from various weather bureau publications
** See Map 2
*** Data not available

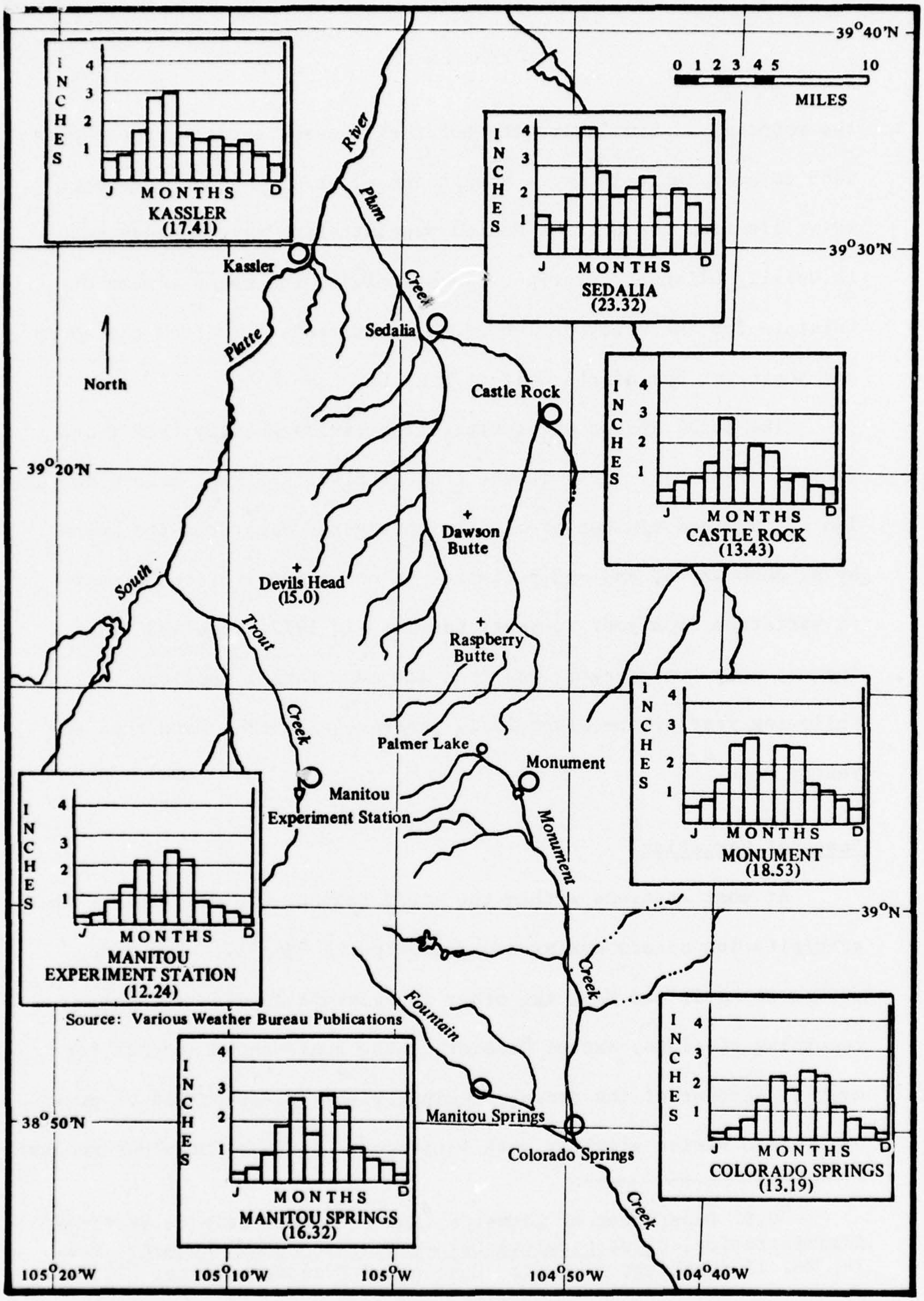
the mountains. Similarly, the polar air masses entering the region tend to be relatively dry. When these polar air masses encounter moist air from the Gulf of Mexico precipitation may be heavy but is usually of short duration. Nevertheless, the major source of moisture for the study region is this warm moist air from the south and southeast out of the Gulf of Mexico.

The total amount of precipitation varies greatly from year to year (Table 4). This is one characteristic of semi-arid climates. The maximum and minimum precipitation figures vary from the means by as much as +68 and -52 percent. As one example of the amount of variation from year to year, Kassler, in 1972, received 17.11 inches, only two percent less than its mean total. But the following year, it received 25.11 inches--44 percent more than the yearly mean.[8]

Seasonal Variation

At most stations within the study region, the majority of the precipitation occurs during two summer peaks (Map 3). One peak occurs in April and May, the other in July and August. At all recording stations, except Kassler, these four months account for over 50 percent of the annual precipitation. Distribution of precipitation varies slightly with latitude as northern stations receive

[8]U.S. Department of Commerce, Environmental Science Services Administration, Climatological Data--Colorado Annual Summary, Vol. 78, No. 13 (Washington, D.C.: Government Printing Office, 1973), p. 1.



PRECIPITATION DATA (in inches)

MAP 3

more moisture in April and May while to the south the wettest periods are July and August. Monument is the exception with the two periods accounting for almost the same percentage of the annual total, 28.6 and 27.4 percent.

April and May

During April and May over the majority of the region, the temperature differential between warm moist air from the Gulf of Mexico and the cooler polar air masses results in the early peak period. Cases of heavy precipitation, often wet snow, occur when a low pressure cell (commonly called the Albuquerque Low) develops over or moves into northern New Mexico. The counter-clockwise circulation around the low brings wet air from the Gulf states and Gulf of California into the region and raises it from under 2,000 feet to over 7,000 feet. While this air moves upslope, its temperature often drops as much as 15 degrees which can cause heavy precipitation. Thus, stations close to the Rampart Range such as Kassler, Sedalia, and Monument have large amounts of precipitation during this time period.

During such periods of such upslope conditions, heavy rains may fall for several days at the same location, resulting in flooding. In May of 1894, the South Platte-Arkansas Divide received 2.5 inches of rain within three days and Colorado Springs almost five inches in a four day period. During a three day period in June of 1921, Colorado Springs reported 4.9 inches of rain while Monument received 4.17 inches.

July and August

The late summer rains of July and August result from convection rather than upslope conditions. As the air warms, large convection cells frequestly form. The resulting rain and thunder showers are common, frequently localized, and often quite intense. Consequently, in some areas, notably the basins of Plum and Monument Creeks, "the maximum probable six hour precipitation over a ten (10) square mile area is twenty-three (23) inches."[9] In July of 1885, for example, a cloudburst northeast of Colorado Springs deposited an estimated sixteen inches of water in one hour.[10]

Kassler, especially, and Sedalia do not experience the large July-August precipitation peaks because of local conditions. Kassler, like Monument and Sedalia, is situated at the base of the Rampart Range; however, west of these more shower-prone towns, the maximum elevations are not over 9,500 feet. In contrast, Kassler lies almost due east of Mount Evans and Mount Bierstadt, both over 14,000 feet high. Consequently, convection cells tend to form further east of the mountains, and the resulting rain misses Kassler. On the other hand, Sedalia, farther east from

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[9] Pikes Peak Area Council of Governments, "Open Spaces: Report I, An Inventory of Park, Recreation and Open Space Facilities, Sites and Programs in the Pikes Peak Region," (Colorado Springs, Colorado, 1970), p. 28. (Typewritten).

[10] Carl F. Mathews, Early Days Around the Divide (St. Louis: Sign Book Co., 1969, p. 26.

Mount Evans and Mount Bierstadt, does have a mild precipitation peak in July and August receiving 22 percent of its annual precipitation.

June 1965

Occasionally these intense convectional cells form in the same general area on two or three successive days. A good example of such storms occurred on 16 June 1965 when a mass of low dark thunderstorm clouds settled over the top of Dawson Butte, Raspberry Mountain, and the western end of the divide near Palmer Lake (Map 4). These clouds were part of a line of convectional storms which extended from Denver to Pueblo. Rather than moving toward the east as such storms normally do, they remained stationary or drifted northward. Fourteen inches of rain fell at both Palmer Lake and Larspur within four hours, while twelve inches fell at Castle Rock.[11] Because the storms moved along the axis of the Plum Creek Basin, severe flooding resulted. The next day, more heavy rains from similar storms fell about twenty miles father east, causing flooding outside the study region.

Snow Storms

Precipitation in the fall decreases as the land cools and convection cells become less frequent. Consequently, most of the

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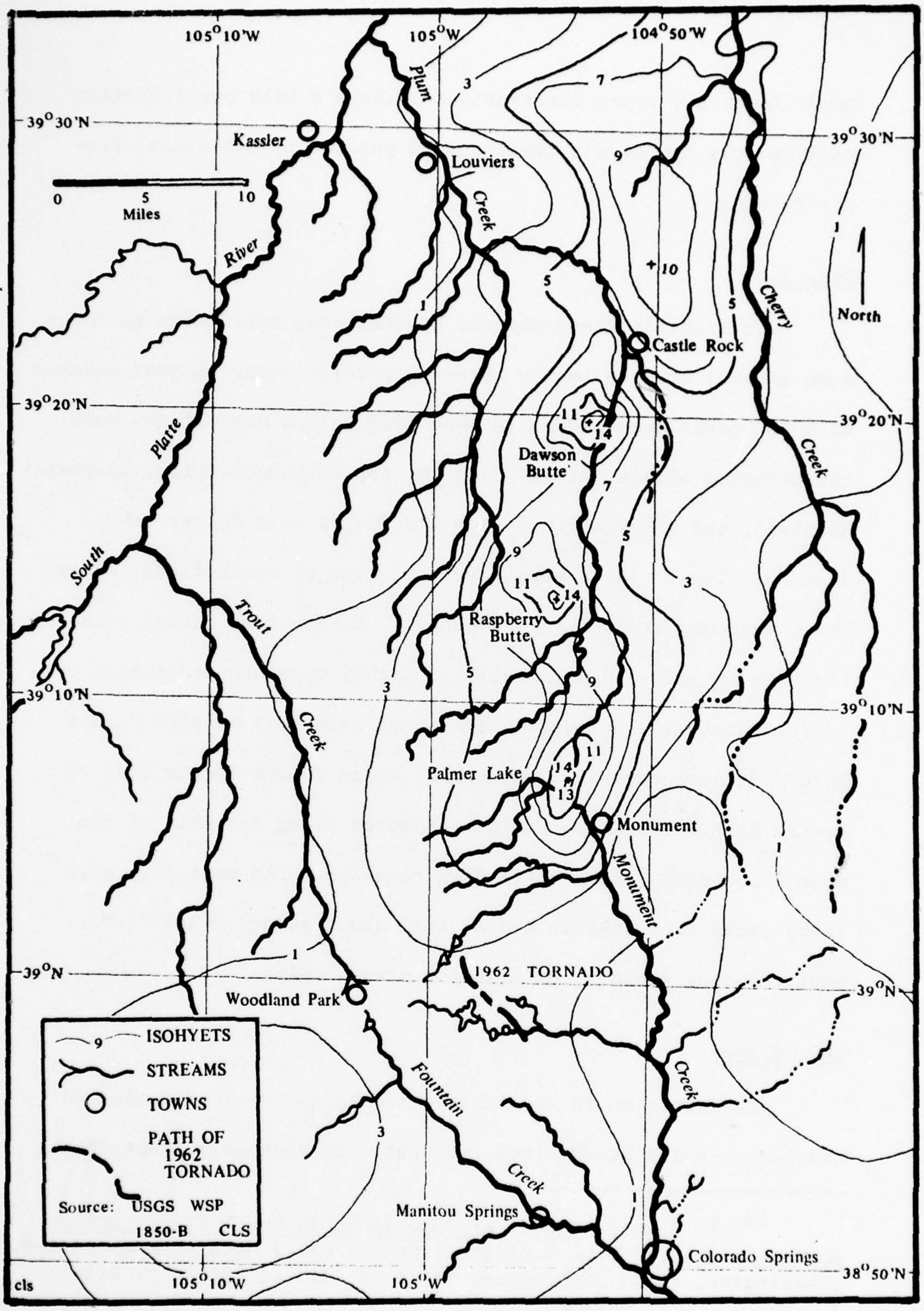
[11] H.F. Mathai, Floods of June,1965, in South Platte River Basin, Colorado. U.S. Geological Survey Water Supply Paper 1850-B. (Washington, D.C.: Government Printing Office, 1969), p. B14.



RAINFALL 16 June 1965
MAP 4

precipitation in the fall and winter, much of it snow, results from the mixing of air masses. The polar air which enters the region tends to be dry, and therefore, winter snows are generally dry.

The South Platte-Arkansas divide tends to influence the distribution of snow. Often the northern part of the study region receives heavy snows while the area south of the divide receives little or no snow. However, the reverse may also be true. In January 1975, the USAF Academy received over eight inches of snow, while immediately north of the divide, only ten miles away, one one inch fell with even less snow farther north.

Like rainfall, snowfall varies greatly and can be high unpredictable (Table 4). A total of forty-two inches fell on Colorado Springs in April of 1957: 111 percent of the average annual snowfall. Single storms can also be extreme. For example, a blizzard began on April 13, 1858, on the divide. A company of U. S. soldiers had camped in clear weather, but as night came, snow began to fall accompanied by strong winds. The blizzard lasted sixty hours, dumped three feet of snow, and froze to death two of the soldiers. Following the storm, warm temperatures returned and the snow soon melted.[12]

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[12] Randolph B. Marcy, <u>Thirty Years of Army Life on the Border</u> (New York: J. B. Lippincott Co., 1962), p. 226.

Evaporation

The amount of precipitation which falls within the study region usually is much greater than the amount of moisture which the soil retains. Frequently, high winds blow from the west, drying the soil rather than bringing moisture. These winds, the dryness of the air, and high ground temperatures tend to try out the soils. In fact, during the summer, evaporation rates in some creeks exceed the water available and the creeks dry up.

Because of all these drying effects, snow in winter seldom stays on the ground at lower elevations for more than a week. Winds often pick up the snow flakes and can clear away an inch of snow very quickly. Drying Chinook winds are also common as the westerly winds descend the 1,000 to 2,000 feet from the crest of the Rampart Range to the plains. These may raise temperatures in the study region by as much as 30°. A Chinook in Denver in 1936 raised the temperature 60° in only a few hour's time.[13]

These Chinooks and the drying winds of summer greatly affect the soil moisture in the plains. However, in December the moisture entering the soils exceeds the rate of evapotransportation and the soils slowly begin to store moisture. By April and May, the rate of evapotransportation increases as does the amount of moisture entering the soil; however, very soon a moisture deficit begins to

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[13] Joseph W. Berry, <u>Climate of the States--Colorado</u> (Washington, D.C.: Government Printing Office, 1968), p. 4.

occur. By the end of July or early August, the moisture stored in soils has been depleted, and, except for isolated rains, the soils will stay dry until the next December.[14]

Wind

Another climatic occurrence in the region is strong wind. When a high pressure cell lies west of the Southern Rocky Mountains with a low pressure cell to the east, the resulting winds can be quite strong. If a low-lying jet stream augments this condition, the winds become extremely strong. Such winds frequently blow roofs off houses, pick up small pieces of sand and gravel which damage buildings, windows, and cars, and topple many trees within the Rampart Range.

Histories of the region are replete with examples. In the early 1870's, a Denver and Rio Grande Railroad car which was being used as housing for rail workers was overturned by strong winds.[15] In February 1887, an express train of twenty-four cars and one caboose was blown completely off the tracks. Several other railroad cars have been overturned. During such high winds, including the Interstate, are closed to traffic.

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[14]Lynn S. Larsen, Soil Survey of Castle Rock Area, Colorado, U. S. Department of Agriculture (n.p.: Soil Conservation Service, 1974), p. 109.

[15]Lloyd McFarling, "Notes on the Early History of the Town of Monument." (n.p.: n.d.), p. 7. (Typewritten).

Tornadoes

Tornadoes are uncommon in the study region but do occur. In 1962, one "danced" along the eastern edge of the Rampart Range for over a mile destroying large areas of forest (Map 4). Tornadoes were sighted near the town of Palmer Lake and south of Castle Rock during the heavy rain storms of June 16, 1965. A tornado was reported about twenty miles northeast of Colorado Springs in July 1975. Such storms are potentially very destructive and can leave huge scars like the one on Raspberry Butte (Photograph 2).

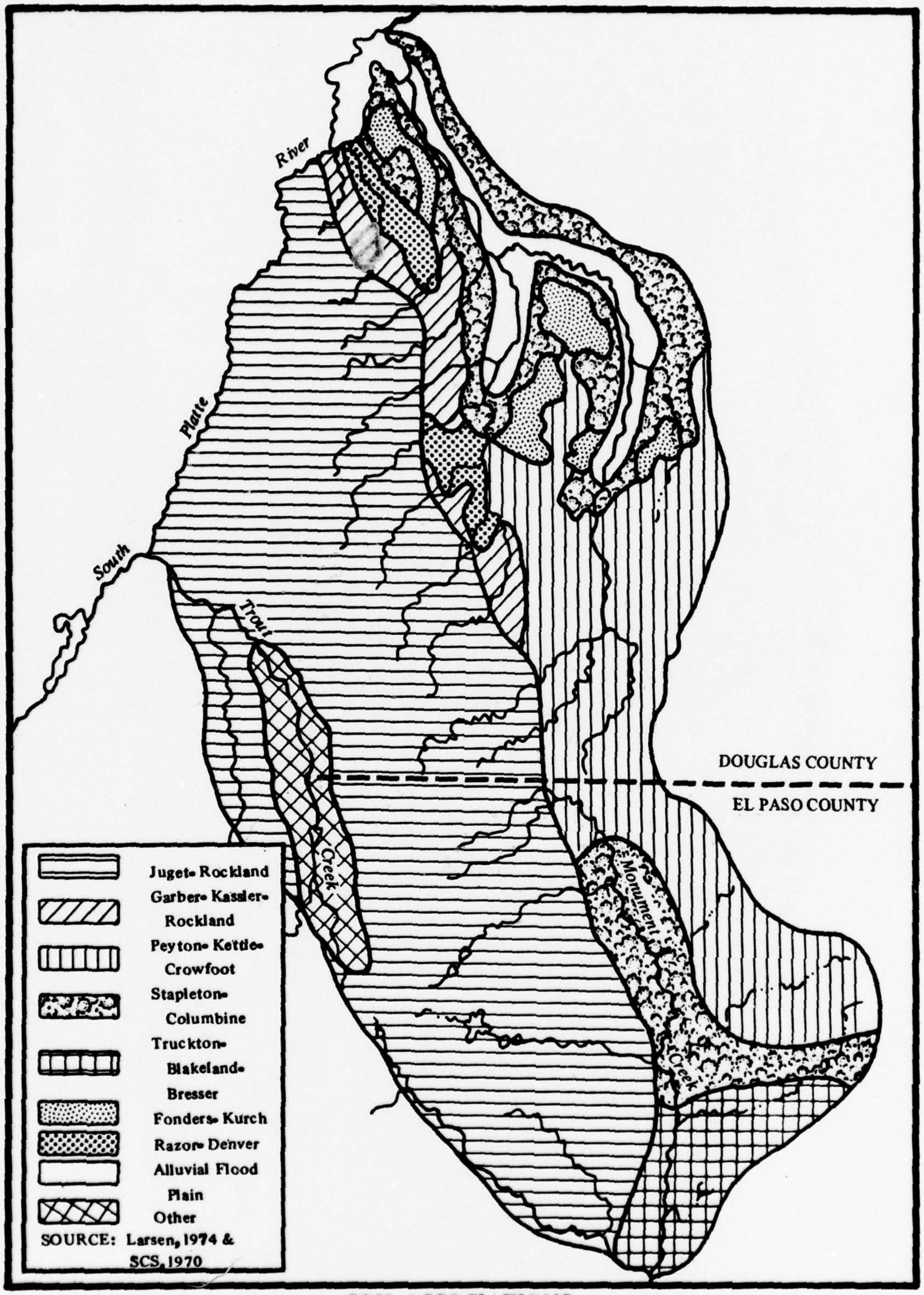
SOILS

As in any area with a wide variety of geological formations, topography, and climate, soils within the study region vary significantly (Map 5). Distribution of soil associations in the region has been determined by the Department of Agriculture's Soil Conservation Service (SCS) regional offices in Douglas and El Paso Counties.

Juget-Rockland Association

The western portion of the study region has soil series derived from Pikes Peak granite which belong to the Jeget and Rockland association as defined by the SCS office in Douglas County and the Juget association by the El Paso County office of the same agency (Map 5). These relatively shallow soils, from 12 to 15 inches thick, lie over the granite and surround the large outcrops of bare rock. Dark grayish brown color characterizes these very

Photograph 2
Tornado Erosional Scar
on Raspberry Butte



SOIL ASSOCIATIONS
MAP 5

gravelly, sandy, loams and loamy sands. Subsoils are more pinkish, reflecting the parent material and are also very coarse and gravelly. The low amount of organic material causes the soils to be infertile.[16] Relative slope and direction of slope also affect the soils of the Juget group, with soils on north facing slopes having slightly finer texture. The overall coarseness of the soils results in the rapid permeability of the soil. The Juget association occurs on steep slopes from twenty to sixty-five degrees, and is subject to extensive erosion with soil slippage a common occurrence.[17]

Graber-Kassler-Rockland Association

Within the foothills portion of the study area, an association of sandy and gravelly soils occurs on terraces, alluvial fans, steep hills, and ridges (Map 5). Identified as the Graber-Kassler-Rockland association in Douglas County, this association is not reported in El Paso County.[18] The Graber-Kassler-Rockland association by the El Paso SCS office. In any case, soils along the base

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[16] William M. Johnson, Effect of Grazing Intensity Upon Vegetation and Cattle Gains on Ponderosa Pine-Bunchgrass Ranges of the Front Ranges of Colorado, U.S. Department of Agriculture Circular 929 (Washington, D.C.: Government Printing Office, 1953), p. 18.

[17] Lynn S. Larsen, Soil Survey of Castle Rock Area, Colorado, U.S. Department of Agriculture (n.p.: Soil Conservation Service, 1974), p. 4.

[18] U.S. Department of Agriculture, Forest Service, Report to Accompany El Paso County General Soil Map of Soil Associations (Colorado Springs, Colorado, 1973), p. 1. (Mimeographed).

of the Rampart Range in both counties vary from deep to shallow and are reddish brown to gray, sandy loams or gravelly loams with from 60 to 70 percent gravel.[19]

Peyton-Kettle-Crowfoot Association

Portions of the divide and the higher parts of the Plum and Monument basins east of the Rampart Range are the locations of a sequence of soils which have developed from the arkoses and arkosic sandstones of the Dawson Formation (Map 5). In Douglas County, this is termed the Peyton-Kettle-Crowfoot association and contains isolated occurrences of the Brussett-Jarre association. The SCS office in El Paso county includes both associations in their Kettle-Pring-Peyton association. Both groupings of soil series are characterized by loamy sands and sandy loams one to three feet deep and of moderate permeability.[20] More sandy soils of the Peyton-Kettle-Crowfoot association cover most of the central part of the study region while the loamy soils of the Brussett-Jarre association are present on the steep sides and tops of many of the mesas with the Jarre series on the steeper slopes. The Jarre series is the only soil type of the three associations which has a gravelly subsoil.[21] Rapid runoff also characterizes the soils

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[19] Larsen, p. 18.

[20] Larsen, p. 31.

[21] Larsen, p. 4.

making erosion and soil slippage common occurrences. If the soils are bare for any period of time, severe erosion may occur (Photographs 3 and 4).

Stapleton-Columbine Association

At elevations in Monument Creek basin lower than the areas of the Kettle-Pring-Peyton association, the Stapleton-Columbine association is present (Map 5). These deep soils have developed from weathered arkosic deposits and are sandy loams or gravelly sandy loams with dark color and a high gravel content.[22] Columbine soils are not found in Douglas County. However, the Bresser-Newlin-Stapleton association occurs in the area of Douglas County which is similar to those where the Stapleton-Columbine association occurs in El Paso County. Soils of the Bresser-Newlin-Stapleton association are grayish brown sandy loams with some gravelly sand subsoils. Bresser soils occupy terraces and uplands with the gravelly sandy loams of the Newlin series on side slopes. Permeability is moderate and runoff and erosion potential range from medium to high.[23]

Truckton-Blakeland-Bresser Association

Immediately surrounding the city of Colorado Springs are soils which have been classified as the Truckton-Blakeland-Bresser

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[22] U.S. Department of Agriculture, Forest Service, Report to Accompany El Paso County General Soil Map of Soil Associations (Colorado Springs, Colorado, 1973), p. 2. (Mimeographed).

[23] Larsen, p. 3.

Photograph 3
Soil Erosion in the Peyton-Kettle-
Crowfoot Association

Photograph 4
Soil Erosion in the Peyton-Kettle-
Crowfoot Soil Association

association (Map 5). These are deep, brown, sandy loam and loamy sands which have developed from noncalcareous sediments and have rapid permeability.[24]

Fonders-Kurch Association

In Douglas County, soils located on the uplands, which developed from shales, sandstones, and older soils, form the Fonders-Kurch association. These are characterized by deep loamy soils with clay subsoils and occur on mesas and upland areas in the northern part of the study region (Map 5). Soil erosion is a problem with this association.

Razor-Denver Association

The Razor-Denver association soils also occurs on uplands in the northern part of the region (Map 5), and are deep clayey soils which have developed over shales. Slow permeability characterize these soils.[25] The Razor-Denver association is subject to soil erosion and soil slippage is a problem.

Alluvial Flood Plains Association

Within the lower valleys of both East Plum Creek and West Plum Creek, the Soil Conservation Service recognizes a loam Alluvial Flood Plain soils association (Map 5). Similar soils may also occur

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[24] U.S. Department of Agriculture, Forest Service, Pike National Forest Colorado, Scale 1:126,720 (Washington, D.C.: U.S. Department of Agriculture, 1970), p. 3.

along the lower reaches of Monument Creek but are not of large enough extent to be mapped. These are deep loamy and sandy loam soils of the flood plains and adjacent terraces. Organic material is present in these dark colored soils which are frequently flooded.[26]

Other Soil Associations

In isolated areas within Manitou Park, the Manitou Embayment, and along the base of the Rampart Range, soils have developed which do not fit into the associations presented. These typically cover only small areas; for example, soils derived from outcrops of the Williams Canyon Limestone are generally dark gray to black with high lime content and large amounts of clay. Such soils tend to hold large amounts of water.[27] Similar soils developed from the Madison Limestone are rich brown in color and also high in clay content. Chert or flint nodules are common in these soils. The soils of Manitou Park are all subject to intense erosion, particularly when the ground is disturbed.[28]

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[26] Larsen, p. 26.

[27] Steven R. Marcus, Geology of the Mountain Zone of Central Colorado--With Emphasis on Manitou Park, U.S. Department of Agriculture Forest Service Research Paper RM-113 (Fort Collins, Colorado: Rocky Mountain Forest and Range Experiment Station, 1973), p. 11.

[28] Dwight R. Smith, Effects of Cattle Grazing on a Ponderosa Pine--Bunchgrass Range in Colorado, U.S. Department of Agriculture Technical Bulletin 1371 (Washington, D.C.: Government Printing Office, 1967), p. 4.

VEGETATION

Vegetation in the Rampart Range and adjacent portions of the Colorado Piedmont can easily be divided into three major types or biomes: grasslands, scrub or brush, and forests (Map 6). In many cases the soil associations discussed in the previous section have a distinctive vegetation cover. In several locations a transition zone exists where these vegetation groups intermingle.

Grassland Biome

Generally, at elevations under 6,000 feet, grasses predominate. The main constituents of the grassland biome are buffalo grass (Buchloe dacyloides) and grama grasses (Buchloe sp) with western wheatgrass (Agropyron Smithii), june grass (Koeleria gracillis), yucca (Yucca glauca), and prickley pears (Opunta rafinesquei) also present. An extension of the short grass prairie of the High Plains, this biome has a mixture of short and tall plants. This is not believed to be the true climax biome of the region but the result of grazing by domestic livestock.[29] This vegetation pattern is relatively extensive in the valleys of Plum Creek, Monument Creek, and some areas on the divide (Map 5 and Photograph 5). In some of the drier areas, the prickley pears and yuccas are very common and plants may occur in bunches. In other areas, patches

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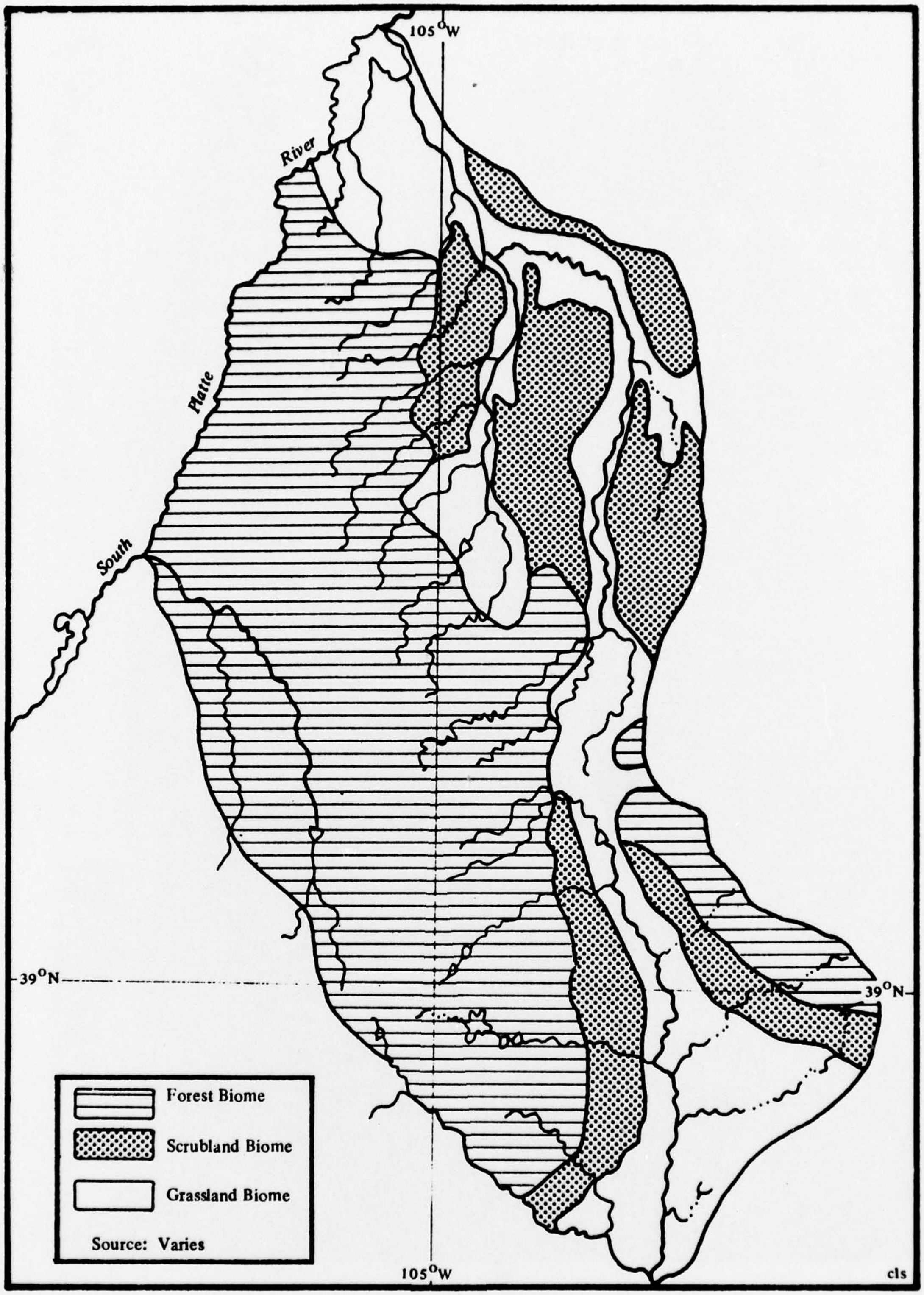
[29] Pikes Peak Area Council of Governments, The Ecology of the Pikes Peak Region (Colorado Springs, Colorado: Pikes Peak Area Council of Governments, 1973), p. 11.



VEGETATION PATTERNS
MAP 6

Photograph 5

Grassland Biome in the Foreground,
Scrub Biome on Slopes
(Northwest of Colorado Springs)

of scrub oak (Quercus gambelii), or ponderosa pines (Pinus Ponderosa), interrupt the grasslands. Streams in the grassy areas are lined with cottonwood trees (Populus sargentii).

Scrub Biome

In places, the scrub or brush-land biome mixes with grasslands, but the typical vegetation from 6,000 to 7,500 feet is dense stands of mountain mahogany (Cercocarpus montanus) and Gambel's or scrub oak (Quercus gambelii) separated by bunch grasses (Map 6). Grasses which occur are widely spaced and yuccas are more common than in the grassland biome. Pin cushion cactus also occurs. Within the scrub biome, vegetation varies widely reflecting soil type, amount of slope, and direction of slope.[30] The scrub biome extends northward from the Manitou Embayment along the eastern edge of the Rampart Range to a point near Indian Creek where the grassland biome extends to the higher forests. In the vicinity of Perry Park, the grasslands of West Plum Creek interrupt the scrub and reach the forested mountains. The scrub biome on the South Platte-Arkansas Divide is somewhat broken by grasses (Map 6). This change in vegetation pattern has been partially caused by man. It may well be that scrub occupied a greater portion of the land in the past as it is common to find the scrub oak present on the

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[30]Pikes Peak Area Council of Governments, The Ecology of the Pikes Peak Region (Colorado Springs, Colorado: Pikes Peak Area Council of Governments, 1973), p. 9.

richer, deeper soils and mountain mahogany on the dry rocky slopes.[31] Also, within this biome stands of ponderosa pine (Pinus ponderosa) occur. These often are on the higher uplands; however, several of the mesas of the region have forested sides with scrub or brush covered tops and several others have brush covered side slopes with forests on top.

Juniper-Pinon Biome

Although the juniper-pinon biome (not shown on Map 6) is reported to occur only south of Colorado Springs,[32] it does occur along the north side of the Manitou Embayment. In addition, some pinons (Pinus edulis) have been observed at the crest of a few pediments on the Air Force Academy; however, these are rare and the biome distribution generally does not occur north of Ute Pass.

Coniferous Forest Biome

Higher elevations within the study region are dominated by a coniferous forest biome. These forests extend upward in elevation from about 7,000 or 7,500 feet (Map 6). Trees of the biome include the ponderosa pine (Pinus ponderosa), Douglas fir (Pseudotsuga

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[31] Wilfred W. Robbins, Natural Vegetation and Climate of Colorado in Their Relation to Agriculture, Colorado State Agriculture College Experiment Station Bulletin 224 (Fort Collins, Colorado: Colorado State Agricultural College, 1917), p. 45.

[32] R. F. Daubenmire, "Vegetational Zonation in the Rocky Mountains," The Botanical Review, IX (June, 1943), p. 340.

menziesii), lodgepole pine (Pinus contorta), white fir (Abie concolor), Englemann spruce (picea englemannii), Aspen (Populus tremutiodes), and blue spruce (Picea pungens).

In the natural state, the south facing slopes at lower elevations may be covered by open stands of ponderosa pine with extensive grass cover (Photograph 6). North facing slopes are populated by dense stands of Douglas fir. These particular trees grow as a consequence of slope and its effect upon soil texture and soil moisture. The Douglas fir is in a climatic environment similar to that encountered on flat surfaces either at higher elevations or farther north. Although most of the forests of the biome originally consisted of mixed stands of Douglas fir and ponderosa pine, pure stands of each species may be present. Mixed stands are the most common although firs prefer cooler and moister areas with the pines preferring drier, warmer locations.[33] In areas where the forest has been destroyed and has not returned to the climax stage, lodgepole pine stands are prevalent. In moist valley bottoms, Aspen and blue spruce are dominant, and pure stands of Engleman spruce occur at elevations about 8,500 feet.

Early reports referred to the forested area of the South Platte-Arkansas Divide as the Pineries. Today the term Black Forest is used for the same wooded area. The water bearing Dawson

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[33]Wilfred W. Robbins, Natural Vegetation and Climate of Colorado in Their Relation to Agriculture, Colorado State Agricultural College Experiement Station Bulletin 224 (Fort Collins, Colorado: Colorado State Agricultural College, 1917), p. 50.

Photograph 6

Pine Forest at Low Elevations
Near Perry Park

Formation near the surface in this area provides moisture and is reflected by the stands of ponderosa pine.[34] However, man has significantly reduced the pine stands on the divide.

SUMMARY

As indicated by this description, extreme variation in climate, soils, and vegetation characterize the study region. These variables are not independent and have very complex relationships, as is shown best by comparing the microclimate, soils, and vegetation of slopes facing to the north with those on south facing slopes.

One factor which has been only briefly discussed in depth is the affect of man upon the variables. Logging has deforested the Rampart Range and foothills at least once. Fires have also deforested the region. The grasslands of the Colorado Piedmont have been altered by introduction of grazing animals, especially sheep. All these activities have damaged the soils, resulting in widespread erosion. Finally, urban growth and automobiles have probably altered the climate by adding particulent material in the atmosphere.

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[34] Thomas N. James (James T. Neal), These Beautiful Hills, (Palmer Lake, Colorado: Filter Press, 1971), p. 19.

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